



ALLIANCE
TECHNICAL SERVICES, INC.



DOE Hydrogen Program

Analysis Repository

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Alliance Technical Services, Inc.

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ANP-5

Overview

Timeline

- Start: FY 2005
- Ongoing
- 60% complete

Budget

- Total project funding:
 - 100% DOE
- FY06 Budget:
 - ATS: \$26,000
 - NREL: \$29,000
- FY07 Budget:
 - ATS: \$26,000 (est.)
 - NREL: \$15,000 (est.)

Systems Analysis Barriers Addressed

- B. Stove-piped/Siloed Analytical Capability
- D. Suite of Model and Tools
- E. Unplanned Studies and Analysis

Partners

- National Renewable Energy Laboratory

Objectives

- **Create a searchable online database of hydrogen-related analyses.**
- **Populate the database with as many hydrogen-related analyses as practical, both DOE- and non-DOE-funded.**
- **Develop a user-friendly interface that provides the needed functionality, particularly regarding search capabilities.**

Approach

- **Identify projects for inclusion in the Repository**
 - All DOE-funded systems analysis projects from present time back to 1995 (component analyses excluded)
 - Other federally funded hydrogen-related analyses conducted since 1995
 - Privately and internationally sponsored hydrogen-related analyses conducted since 1995
- **Determine data needs**
- **Gather data**
 - Publications
 - Principal investigators
- **Develop database of projects**
- **Create searchable online tool for displaying the data**

Index Card Approach

The repository is, at a minimum, like a library catalogue. Each entry in the repository should contain enough information on the analysis or model to identify its general purpose and scope and enable the user to locate further information.

Input Form – Required Data

REPOSITORY DATA SHEET	
Required Section. The information on this page is required in order for your project to be entered into the repository.	
Title: Common title used to identify model (both long form and short form or acronym). If the project previously had a different title, please provide past titles as well.	Index #: To be completed by administrators
Sponsor Name:	Sponsor Phone Number:
Sponsor Organization:	Sponsor Email Address:
Type of Project:	Date This Form Last Updated:
<input type="checkbox"/> Analysis	
<input type="checkbox"/> Model	
<input type="checkbox"/> Both	
Performer/PI:	Performer Physical Address:
Organization:	Performer Phone Number:
	Performer Email Address:
Additional Performers (subcontractors/teammates): lab, company, university, etc. (please provide name and organization of each additional performer)	
Contact Information for User Questions (if other than PI):	
Period of Performance:	Timeframe Studied (range of years, e.g. 2005-2020):
Start (month, year):	
End (month, year):	
Purpose of Analysis/Model: Describe why the analysis or model is needed.	Category (choose all that apply; descriptions given on next page):
	<input type="checkbox"/> Hydrogen fuels pathway
	<input type="checkbox"/> Vehicle options
	<input type="checkbox"/> Well-to-wheels
	<input type="checkbox"/> Energy infrastructure
	<input type="checkbox"/> Macro-economic
	<input type="checkbox"/> Environmental
	<input type="checkbox"/> Cross-cutting
Objectives (i.e., Question(s) to Be Answered by the Analysis/Model): Separate with semicolons.	

Description of Categories

- Hydrogen fuel pathways
 - Includes resource analysis, production and delivery pathway analysis, transition modeling specific to hydrogen fuel pathways, cost analysis and modeling relevant to hydrogen fuel, and lessons learned from other alternative fuels specific to development of a hydrogen infrastructure
- Vehicle options
 - Includes vehicle systems analysis, vehicle penetration analysis/modeling/forecasting, market/consumer analysis for both transition and long-term, lessons learned from other AFVs, competitive impacts (plug-ins, hybrids, etc.), cost analysis and modeling specific to vehicle options
- Well-to-wheels
 - Assessment of life cycle impacts of technologies, including impacts of feedstock recovery, fuel production, fuel delivery, and vehicle operation

Description of Categories

- Energy infrastructure
 - Includes macro-system modeling as well as analysis and modeling of non-hydrogen energy infrastructures
- Macro-economic
 - Analysis and modeling of macro-economic systems
- Environmental
 - Includes analysis of environmental effects of hydrogen, hydrogen infrastructure, fuel cells, etc.
- Cross-cutting
 - Includes analysis of infrastructure elements needed to support a hydrogen economy, including water, fuel quality, etc.

Input Form – Optional Data

REPOSITORY DATA SHEET			
<p>Optional. This page and the pages following are to provide additional information on your project. This will help users of the repository quickly and easily obtain useful information on your project without contacting you.</p>			
<p>All Projects</p>			
<p>Methodology/Approach: List models and techniques used in conducting the analysis or model; e.g., discounted cash flow analysis, Monte Carlo simulation, linear algebraic calculation. Separate with semicolons.</p>			
<p>Outputs: List the outputs of the analysis or model; e.g., delivered cost of hydrogen, WTVV energy use and CO2 emissions, etc. Separate with semicolons.</p>			
<p>Keywords: The data contained in this data sheet will be included in a repository. Search capability will be included to make the data accessible to the analysis community. Please list up to 15 keywords that should be used to find this model with a search engine. Separate with semicolons.</p>			
<p>Milestones Supported by this Project: Does your project support any DOE Hydrogen Program (or other government entity) decision/milestones? For list of DOE Hydrogen Program milestones, see the RD&D Plan at http://www.eere.energy.gov/hydrogenandfuelcells/mvpp/</p>			
Organization with Milestone	Description of Milestone	How does your project contribute to achieving the milestone?	Completion Date (can be expected date if not yet achieved): month, year
<p>Project Reviews: List and attach any project reviews that have been completed. Provide URLs if available.</p>			
Title		URL	

Input Form – Optional Data Analyses

Analyses Only			
Technologies Considered: List all technologies that are analyzed, e.g. steam methane reforming; fuel cell vehicles; metal hydride hydrogen storage. Separate with semicolons.			
Models Used: List models used in conducting the analysis, including both commercially available and proprietary models. Separate with semicolons.			
Assumptions: List the key assumptions affecting the results of the analysis. Separate with semicolons.			
Sensitivities Studied: List the independent and dependent variables for any sensitivity studies that were conducted. Separate with semicolons.			
Inputs: Describe the inputs to the analysis, e.g. hydrogen production rate, feedstock costs.			
Description	Value (please enter a number only)	Units	Supporting Information (example: At 5,000 psig)

Input Form – Optional Data – Models

Models Only			
Technologies Modeled: List all technologies that are modeled, e.g. steam methane reforming; fuel cell vehicles; metal hydride hydrogen storage. Separate with semicolons.			
User Inputs: Describe the inputs to the model, e.g., hydrogen production rate; feedstock costs. Separate with semicolons.			
Model Hardware/Software Requirements: List hardware and software requirements for running the model, including hard drive storage, software programs, speed requirements, etc. Separate with semicolons.			
User Interface: Is there a GUI? If yes, describe it (executable file, etc.)			
Assumptions Inherent in the Model: List the key assumptions affecting the results of the model that are not user inputs. Separate with semicolons.			
Sensitivities Studies Facilitated: List the independent and dependent variables for any sensitivity studies that can be conducted using the model. Separate with semicolons.			
Inputs: Describe the inputs to the analysis, e.g. hydrogen production rate, feedstock costs.			
Description	Value (please enter a number only)	Units	Supporting Information (example: At 5,000 psig)

Input Form – Optional Data Work Products

PRODUCTS / DELIVERABLES	
List the expected outputs and products of the project, e.g., reports, SOW, briefings/presentations, models, model descriptions/users' manuals, etc. Fill out all applicable fields below. Required fields are marked with an asterisk (*). Attach deliverables or list the URLs where they can be found. Please copy this table and repeat for each product and deliverable for the project.	
*Product Description:	
Publication Title:	
Article/Abstract Title:	
Article/Abstract Page Number:	
Name of Publisher:	
Type of Publication:	
Publication Notes:	
Author Name:	
URL:	
*Pub. Date (month, year): For a model, this is the date of release of the listed version of the model	

Input Form – Optional Data – Related Studies

RELATED STUDIES			
Optional. The information on this page will help to identify additional projects that should be included in the repository and to draw relationships between repository entries.			
Data Used/Contributing Research:			
List any previous or concurrent studies that were used in the analysis, used in the model or in developing the model, databases used, or research that contributed to the results.			
Description of Contributing Research		URLs to Contributing Studies, Databases, etc.	
Related Analyses and Models:			
List any analyses or models that contributed to your project, any complementary analyses or models, and any analyses or models that used the results or products of your project. Include the relationship to your project and the location (URL or physical address) where the related analyses can be found (if possible). You need not duplicate any of the items listed above as contributing research.			
Title:	Relationship (does the analysis listed contribute to your project, complement your project, use the results of your project, or is it related another way?):	URL:	Organization
	<input type="checkbox"/> Contributor		
	<input type="checkbox"/> Complementary		
	<input type="checkbox"/> User		
	<input type="checkbox"/> Other		
	<input type="checkbox"/> Contributor		
	<input type="checkbox"/> Complementary		
	<input type="checkbox"/> User		
	<input type="checkbox"/> Other		
	<input type="checkbox"/> Contributor		
	<input type="checkbox"/> Complementary		
	<input type="checkbox"/> User		
	<input type="checkbox"/> Other		

Analysis Repository is live!



The screenshot shows the top of the hydrogen.energy.gov website. The header includes the U.S. Department of Energy logo and the text "Hydrogen Program". On the right, there is a search bar with the text "SEARCH REPOSITORY" and a search button. Below the header, the page title "Analysis Repository" is displayed. A navigation menu on the left lists: Analysis Projects, Modeling Projects, Projects by Title, Projects by Performing Organization, Projects by Principal Investigator, and Projects by Date. The main content area contains a paragraph describing the repository, a list of topics, a paragraph about the repository's purpose, a section titled "Finding Information" with a descriptive paragraph, a paragraph about search methods, and a section titled "Submitting Your Project" with contact information for Melissa Lott.

U.S. DEPARTMENT OF ENERGY
Hydrogen Program

hydrogen.
energy.gov

SEARCH REPOSITORY

Analysis Repository

- > Analysis Projects
- > Modeling Projects
- > Projects by Title
- > Projects by Performing Organization
- > Projects by Principal Investigator
- > Projects by Date

The Analysis Repository is a compilation of analyses and analytical models relevant to assessing hydrogen fuel and fuel cell issues. Projects in the repository relate to

- Hydrogen production, delivery, storage, fuel cells, and hydrogen vehicle technology
- Hydrogen production feedstock cost and availability
- Electricity production, central and distributed
- Energy resource estimation and forecasting.

The U.S. Department of Energy created this repository to help analysts, policy makers, businesses, government agencies, and others quickly and easily locate information on hydrogen analyses.

Finding Information

This database is structured much like a library catalog. Each project entry contains information on the principal investigator, sponsor, and purpose—providing enough information for additional searches elsewhere if more information is needed. In some cases, more project details are included, such as reports, links to models, and other related data.

You can find projects using different approaches. The left-hand navigation allows for browsing by either analysis or modeling projects. You can also browse by title, performing organization, principal investigator, and completion date. The search box at the right hand top allows for searches by keyword.

Submitting Your Project

To submit information on your hydrogen analysis project or model, please contact [Melissa Lott](#).

Accomplishments

- **Analysis Repository went live on May 8**
- **Approximately 75 projects included**
- **Projects are sorted by**
 - **Type of analysis/model (cross-cutting, energy infrastructure, environmental, hydrogen fuel pathways, macro-economic, vehicle options, well-to-wheels)**
 - **Model vs. analysis**
 - **Title**
 - **Performing organization**
 - **Principal investigator**
 - **Date**
- **Search feature is available**

Analysis Projects Sorted by Category

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SEARCH REPOSITORY >

Search Help

Analysis Repository

- > Analysis Repository Home
- > **Analysis Projects**
- > Modeling Projects
- > Projects by Title
- > Projects by Performing Organization
- > Projects by Principal Investigator
- > Projects by Date

Hydrogen Analysis Projects

Below are hydrogen analysis projects grouped by topic.

Energy Infrastructure

- [Application of the GREET Model to the RBAEF Project](#)

Environmental

- [Cost Analysis of Hydrogen Storage Systems](#)
- [IEA Hydrogen Annex 13 Transportation Applications Analysis](#)

Hydrogen Fuel Pathways

- [A Smooth Transition to Hydrogen Transportation Fuel](#)
- [An Analysis of Hydrogen Production from Renewable Electricity Sources](#)
- [Application of Biomass Gasification for Farming Operations Using Microturbines and Fuel Cells](#)
- [BIGCC](#)
- [Biological Water-Gas Shift Conversion of Carbon Monoxide to Hydrogen](#)
- [Boundary Analysis for H2 Production by Fermentation](#)
- [Cost Analysis of Hydrogen Storage Systems](#)
- [Cost and Performance of H2 Fueling Appliances](#)
- [Costs of Storing and Transporting Hydrogen](#)
- [Distributed Hydrogen Fueling Systems Analysis](#)
- [Examining Hydrogen Transitions](#)
- [Hydrogen Delivery Infrastructure Options Analysis](#)
- [Hydrogen from Renewable Energy Sources](#)
- [Hydrogen Infrastructure Costs](#)
- [Hydrogen Infrastructure Report](#)
- [Hydrogen Systems Analysis, Education, and Outreach](#)



Analysis Projects Sorted by Title

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SEARCH REPOSITORY

[Search Help](#)

Analysis Repository

- > Analysis Repository Home
- > **Analysis Projects**
- > Modeling Projects
- > **Projects by Title**
- > Projects by Performing Organization
- > Projects by Principal Investigator
- > Projects by Date

Hydrogen Analysis Projects by Title

Below are hydrogen analyses and analytical models grouped by title.

[A](#) | [B](#) | [C](#) | [D](#) | [E](#) | [F](#) | [G](#) | [H](#) | [I](#) | [L](#) | [M](#) | [P](#) | [R](#) | [S](#) | [T](#) | [U](#) | [V](#) | [W](#)


A

- [A Smooth Transition to Hydrogen Transportation Fuel](#)
- [ABMS for Hydrogen Transition Analysis](#)
- [Advanced Vehicle Cost and Energy-use Model \(AVCEM\)](#)
- [ADVISOR](#)
- [AFVTA](#)
- [AirCRED Model](#)
- [AMIGA Model](#)
- [An Analysis of Hydrogen Production from Renewable Electricity Sources](#)
- [Application of Biomass Gasification for Farming Operations Using Microturbines and Fuel Cells](#)
- [Application of the GREET Model to the RBAEF Project](#)
- [ASCM](#)
- [AVID Model](#)

B

- [BEopt](#)
- [BIGCC](#)
- [Biological Water-Gas Shift Conversion of Carbon Monoxide to Hydrogen](#)
- [Boundary Analysis for H2 Production by Fermentation](#)

C



Analysis Projects Sorted by Performing Organization

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SEARCH REPOSITORY >

Search Help

Analysis Repository

- > Analysis Repository Home
- > **Analysis Projects**
- > Modeling Projects
- > Projects by Title
- > **Projects by Performing Organization**
- > Projects by Principal Investigator
- > Projects by Date

Hydrogen Analysis Projects by Performing Organization

Below are hydrogen analyses and analytical models grouped by performing organization.

A D E E F G I L M N O P R S T U W

A

Aalborg University

- [Large-scale Integration of Wind Power into Different Energy Systems](#)

Air Products

- [Validation of an Integrated System for a Hydrogen-Fueled Power Park](#)

Argonne National Laboratory (ANL)

- [ABMS for Hydrogen Transition Analysis](#)
- [AirCRED Model](#)
- [AMIGA Model](#)
- [Application of the GREET Model to the RBAEF Project](#)
- [AVID Model](#)
- [Ethanol-Diesel Blends in Buses and Framing Tractors](#)
- [Examining Hydrogen Transitions](#)
- [GREET Model](#)
- [MARS Model](#)
- [PSAT](#)
- [VISION Model](#)

D

Directed Technologies, Inc. (DTI)



Sample Project – Part 1

Cost Analysis of Hydrogen Storage Systems

Project Summary

Full Title:	Cost Analysis of Hydrogen Storage Systems
Project ID:	DOE-145
Principal Investigator:	Stephen Lasher
Sponsor Name(s):	Sunita Satyapal
Keywords:	Hydrogen storage; lifecycle costs; compressed hydrogen tanks

Purpose

The purpose of this analysis is to help guide researchers and developers toward promising R&D and commercialization pathways by evaluating the various on-board hydrogen storage technologies on a consistent basis.

Performer

Principal Investigator: Stephen Lasher

Organization: TIAX, LLC

Address: Acorn Park
Cambridge, MA

Telephone: 617-498-6108

Email: lasher.stephen@tiaxllc.com

Additional Performers: John Bowman, TIAX LLC; Matt Hooks, TIAX LLC; Mark Marion, TIAX LLC; Stephan Unnasch, TIAX LLC; Yong Yang, TIAX LLC

Sample Project – Part 2

Project Description

Type of Project: Analysis

Category: Environmental, Hydrogen Fuel Pathways, Vehicle Options, Well-to-Wheels

Objectives: Compare different on-board hydrogen storage approaches in terms of lifecycle costs, energy efficiency and environmental impact; Identify and compare other performance aspects that could result in barriers to successful commercialization (e.g., on-board system weight and volume); Examine the effects of system-level cost and performance trade-offs for different storage approaches; Project performance and cost relative to DOE targets

Technologies Considered: Sodium alanate; Sodium borohydride; Magnesium hydride; Carbon fiber compressed gaseous tanks; Cryo-compressed tanks; Liquid Hydrogen tanks; Reversible on-board hydrogen storage; Regenerable off-board hydrogen storage; High surface area sorbents

Methodology/Approach: System-level conceptual designs will be developed for each on-board storage system and required fueling infrastructure. In-house activities- and product-based cost models will be utilized to determine high-volume manufactured cost projections for the on-board storage system. Monte Carlo simulation will be used for cost sensitivity analyses. H2A-based discounted cash flow models will be used to estimate hydrogen selling prices based on the required off-board hydrogen infrastructure.

Models Used: In-house activities- and product-based cost models will be utilized to determine high-volume manufactured cost projections for the on-board storage system. H2A-based discounted cash flow models will be used to estimate hydrogen selling prices based on the required off-board hydrogen infrastructure.

Outputs: On-board storage system cost and performance; delivered cost of hydrogen; lifecycle or well-to-wheel cost, primary energy use, and environmental impact

Sensitivities Studied: Single variable sensitivity analyses were run on the overall sodium alanate system cost, weight, and volume for four system parameters: media reversible hydrogen capacity (H₂ wt%), media cost (\$/kg), tank carbon fiber layer thickness (mm) and media relative packing density.

Sample Project – Part 3

Products/Deliverables

Description: Abstract in FY 2005 Progress Report for the DOE Hydrogen Program
Title: *FY 2005 Progress Report for the DOE Hydrogen Program*
Article/Abstract Title: Analyses of Hydrogen Storage Materials and On-Board Systems
Page number(s): 671
Publisher: U.S. Department of Energy
Type of Publication: Annual Progress Report
Author Name(s): Lasher, Stephen
([PDF 360 KB](#)) [Download Adobe Reader](#).
Publication Date: October 2005

Description: Abstract in FY 2004 Progress Report for the DOE Hydrogen Program
Title: *FY 2004 Progress Report for the DOE Hydrogen Program*
Article/Abstract Title: Analyses of Hydrogen Storage Materials and On-Board Systems
Page number(s): 258
Publisher: U.S. Department of Energy
Type of Publication: Annual Progress Report
Author Name(s): Lasher, Stephen
([PDF 207 KB](#)) [Download Adobe Reader](#).
Publication Date: December 2004

Description: Abstract in FY 2006 Progress Report for the DOE Hydrogen Program
Title: *FY 2006 Progress Report for the DOE Hydrogen Program*
Article/Abstract Title: Cost Analysis of Hydrogen Storage Systems
Page number(s): 535
Publisher: U.S. Department of Energy
Type of Publication: Annual Progress Report
Author Name(s): Lasher, Stephen
([PDF 1.4 MB](#)) [Download Adobe Reader](#).
Publication Date: October 2006

FY 2007/2008 Plans

- **Collect data on additional projects and update/expand data on existing projects in the Repository**
- **Solicit feedback from the analysis community to improve both the data and the structure of the Repository tool**
- **Implement improvements based on feedback – evolve the tool so that it can become a valuable resource for the analysis community and decision-makers**

Summary

Relevance: The Repository is a tool for analysts and decision-makers to find information on analyses and models quickly and easily.

Approach: Develop a searchable online database containing, at a minimum, the purpose of each analysis and modeling project and a means of locating more information.

Accomplishments and Progress: Analysis Repository is live and contains ~75 entries.

Proposed Future Plans: Expand and add entries; solicit feedback from analysis community and incorporate improvements.

Questions? Suggestions?

Your input is important to us!



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